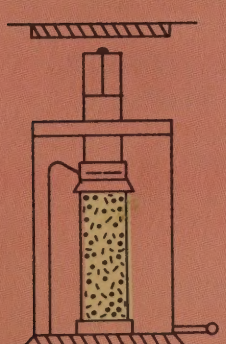
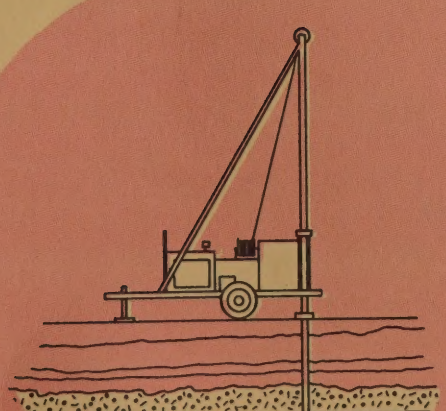
STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS BUREAU

CASE STUDY

DECEMBER, 1983





SLURRY TRENCH SEEPAGE BARRIER

KINGSTON NORTH-SOUTH ARTERIAL

DELAWARE AVENUE INTERCHANGE

D95913

ULSTER COUNTY

PIN 8139.01-321

SM 238b (1/73)

STATE OF NEW YORK

DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS BUREAU

CASE STUDY

SLURRY TRENCH
SEEPAGE BARRIER

ON

KINGSTON NORTH SOUTH ARTERIAL
DELAWARE AVENUE INTERCHANGE
D95913
ULSTER COUNTY

PIN 8139.01-321

BY

RICHARD S. GRANA
SENIOR SOILS ENGINEER

DECEMBER, 1983

I. INTRODUCTION

Proposed construction of a ramp on the subject project posed a definite threat to the continued existence of a pond. The problem was the possibility of pond water seeping out and exiting on a cut slope for a ramp located adjacent to, and at a lower elevation than the pond. The recommended solution to the problem by this Bureau was the construction of a slurry trench seepage barrier between the ramp and the pond in the affected area. To the best of our knowledge, this was the first to be constructed by the New York State Department of Transportation.

II. PROJECT DESCRIPTION

In April of 1979, Contract D95913 was let for a portion of the Kingston North-South Arterial. The construction consisted of a small piece of mainline pavement (.46 mi.) and a complete interchange with Delaware Avenue. Figure 1 indicates the general location of the project while Figure 2 shows the actual problem area.

The design of the project was done by McFarland-Johnson-Gibbons Engineers, Inc. with review, letting and award by the New York State Department of Transportation. Construction inspection was performed by Clough Associates in conjunction with the State.

III. DESIGN

During a review of the project with respect to possible soil or rock problems, it was determined that the proposed construction of "D" ramp posed a potential problem. The new ramp, an on-ramp from Delaware Avenue to the arterial northbound, would be constructed in a maximum 20 foot cut about 70 feet away from Kingman Pond. A review of the borings indicated a silty sand overlying clayey silt containing layers of fine sand. Concern was expressed as to the possibility of draining the pond by progression of the cut due to

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future underground seepage through the silty sand to the cut slope. The recommended treatment by the Soil Mechanics Bureau, in conjunction with the Regional Soils Engineer, was the use of a slurry trench seepage barrier. The slurry trench barrier was designed three feet wide and extended approximately 400 feet around the affected area of the pond. Excavation was to be progressed to elevation 175 which resulted in a trench depth of approximately 15 feet. (See Figure 3). Excavation to this elevation took the bottom of the trench into the clayey silt layer. Since part of the trench location fell within the existing pond, it was necessary to construct a dike so construction of the trench could be made above water. A special note was included in the proposal which required the Contractor to install the slurry trench barrier prior to any excavation for the "D" ramp.

The specification for the slurry trench was developed to include excavation, mixing of the slurry fluid, mixing of the backfill (soil and slurry), and the actual backfill placement. Payment was made on a cubic yard basis. (See specification in Appendix.) An estimate of 500 cubic yards was included in the proposal.

IV. CONSTRUCTION

Yonkers Contracting was the prime contractor for the project. The mixing of the slurry fluid and supervision of the mixing of the backfill soil and slurry was performed under the direction of Moretrench American Corporation of Rockaway, New Jersey. Excavation of the trench, mixing and placement of the backfill material was performed by Yonkers.

Mixing of the slurry was done in a 6,000 gallon tanker furnished by Moretrench. (Photo 1.) Water was obtained by either pumping from Kingman Pond or, when the pump broke down, from a public supply. (Photo 2.) Eighteen bags of bentonite were added to the approximately 6,000 gallons of

water resulting in the minimum 4% by weight of Bentonite required by the specification. Thorough mixing in the tanker was accomplished by circulation through a header-pipe system as seen in Photo 3. Total time to prepare an acceptable batch of slurry fluid was approximately 45 minutes. Even though there was no specification requirement to do so, the Consultant chose to test the viscosity of the mix by the use of a Marsh Funnel Viscometer. (See Photo 4.) A measure of viscosity was made by filling the funnel with 1500 cc's of slurry fluid and timing the rate for 1 quart (946 cc's) to flow out. Industry recommends a viscosity of 35-40 seconds minimum for a slurry trench application. Readings in this range were obtained for the specified mix.

Excavation of the trench was performed by a Cat. 235 Backhoe with an approximate 1 cubic yard bucket. As the excavation was being progressed, slurry fluid was continually pumped into the trench. (See Photos 5, 6, 7.) This procedure was carried out until the 6,000 gallons of slurry was utilized; usually in from 20-30 minutes. A 45 minute delay then ensued while a new batch of slurry was mixed. Excavation of the trench progressed in this manner for a distance of 75 feet, at which time mixing of the backfill started.

The backfill mixture consisted of 10 parts by weight of soil to 1 part slurry fluid. Mixing was performed in a basin constructed near the trench. At the start, a Gradall and the backhoe did the mixing by spreading acceptable natural soil over a pool of slurry fluid and working it with both buckets. (See Photos 8, 9, 10, 11.) When the mixture was at the right consistency, backfill operations commenced. The right consistency was determined "by feel" of the foreman of Moretrench.

Prior to initial backfilling, slurry fluid was withdrawn from the trench, by pumping, to a depth of from 3 to 4 feet below original ground to

allow for displacement by the backfill. This slurry was re-used at a later time. It was noted that a caking of bentonite had occurred along the trench walls. Placement of the backfill was started at one end of the trench by the Gradall and continued until it appeared above the level of the slurry. (See Photo 12.) Subsequent backfill was placed so as to slide down the sloping face thus advancing the backfill operation. The Consultant checked depths and widths of the trench with the use of a graduated pole. (See Photo 13.) Also determined for information, was the slope of the advancing fill. It was found to range between a 1 vertical on 2 horizontal to 1 vertical on 3 horizontal.

The use of a Gradall to mix and place the backfill was found to be a very slow process. The Contractor very quickly eliminated the Gradall and replaced it with a Cat. 977 Track Loader which performed both operations quicker and satisfactorily. (See Photos 14, 15.) The whole operation was executed between July 8 and July 16, 1980. The Contractor chose to cover the completed trench area with 2 feet of broken rock for safety reasons. (See Photo 16.) The Contractor was paid for 541 cubic yards of trench at his bid price of $70 per cubic yard.

V. GENERAL

To gather some information on the natural backfill soil and on the actual backfill mixture of slurry and soil, a sample of each was obtained and tested during construction. Gradation, specific gravity and permeability tests were performed. The results of all testing can be found in the Appendix.

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A more specific specification requirement concerning the type and quality (grade) of Bentonite should be stated based on the intent of the construction.

B. Slurry

1) Reference should be made to a minimum Marsh Funnel Viscometer reading.

2) A water quality requirement should be included.

C. Backfill Material

1) A specific gradation requirement should be included and not have acceptance based on a visual approval of the Regional Soils Engineer.

2) If the slurry and natural backfill material are to be mixed proportionately by weight as specified, a pug-mill or other approved mixing operation should be required.

D. General

The Contractor should be required to supply any test equipment as needed.

The Consultant's comments have merit and should be evaluated for future projects. It is important to realize that it is impossible to write one specification for all projects and that each project and application should be looked at individually.

VII. POST-MORTEM

Approximately six months after completion of the seepage barrier, two events occurred which are worth mentioning. During construction of the ramp, water started seeping from the cut slope. (See Photo 17.) It is believed that this water was trapped between the slurry barrier and the newly formed cut slope face. Filter cloth and a two foot blanket of slope protection was utilized as stabilization where required. (See Photo 18.)

The second, and more spectacular, event to occur can be clearly seen in Photo 19. The pond dried up!! This occurred a short time after completion of the seepage barrier. Contrary to popular belief, this "happening" probably was due to the severe drought which had plagued the area for approximately one year and not the installation of the seepage barrier. To set the record straight, the pond began re-filling in November of 1980, and eventually reached its normal water elevation. (Photo 20.) No additional distress has occurred to the cut slope.

VIII. CONCLUSION

Based on experience obtained during construction, it appears that no major problems exist with the design and use of a slurry trench as a seepage barrier. Some minor adjustments should be made to the specification. Each application should be studied separately and the specification modified for the intended use. This study should include the need for specifying the backfill and slurry mixture in terms of proportion by weight or in a more general manner. A cost-benefit determination should be made.

St Marys Cemetery
KINGSTON
KINGSTON ST
GARRISON ST
Kingman Park
Quarry
OLD
Substation
Lighto
HUDSON
DELAWARE AVENUE
Kingston Point
PS4
Ponck Hockie
Mud
GRADE
Hasbrouck Park
Rondout
E UNION ST
RAILROAD
CORP
EDY
Lighthouse
Sewage Disposal
Tidal Flat
Sleightsburg
KINGSTON URBAN AREA
BOUNDARY IS DEFINED AS
FOLLOWING THE SHORELINE
PIPELINE
RONDOUT
Connelly
Rhinec

FIGURE 1

REG. NO.	STATE	PROJECT NO.
1	N.Y.	F-11(106)
CITY OF KINGSTON		
NORTH - SOUTH ARTERIAL		

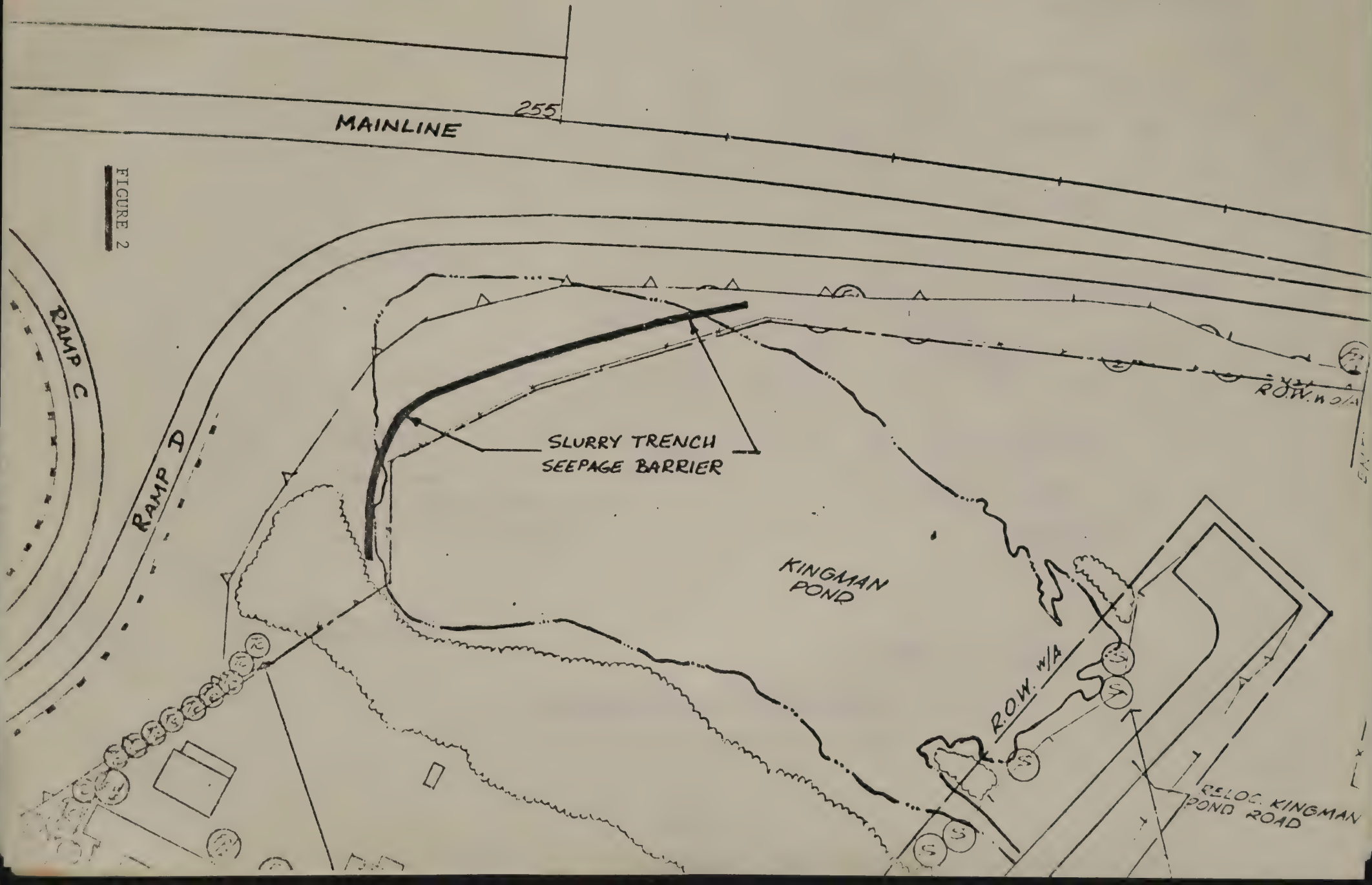


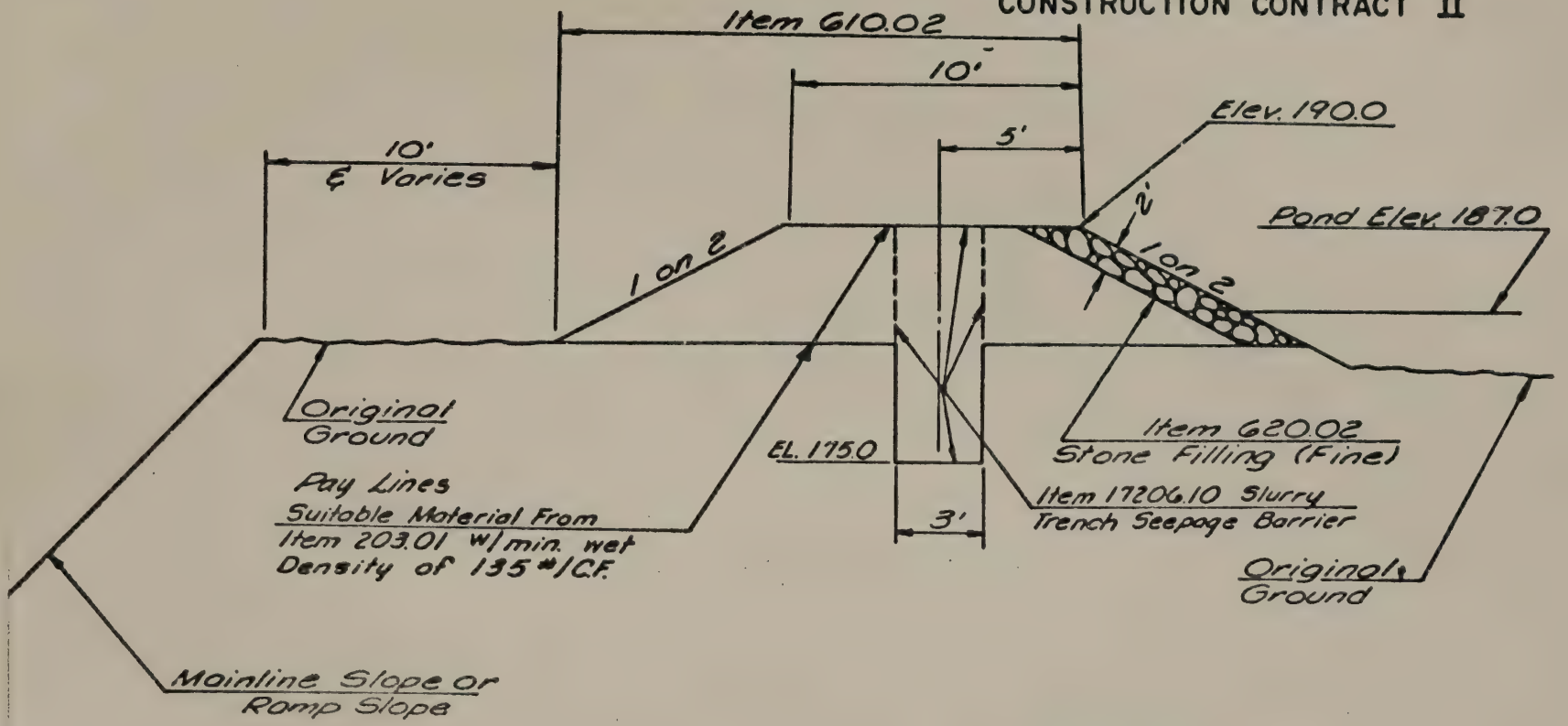
FIGURE 2

D95913

FED. RD. REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	NEW YORK	F-11(105)	33	145

CITY OF KINGSTON
NORTH-SOUTH ARTERIAL HIGHWAY

CONSTRUCTION CONTRACT II



D14+80 ± to D 18+80 ±

KINGMAN POND DIKE

(NOT TO SCALE)

FIGURE 3

APPENDIX

SM 105b (11/72)

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION — BUREAU OF SOIL MECHANICS

SHEET NO. 1 OF 1

DATE July 1980

SUMMARY OF LABORATORY TEST RESULTS

PROJECT _____ SECTION ___ COUNTY _____ PIN NO. _____

LABORATORY NO.			OPT. MOISTURE - %	MAX. DRY DENSITY LBS. PER CU. FT.	SP. GR. + No. 40	LIQUID LIMIT %	PLASTIC LIMIT %	SEIVE ANALYSIS / MECHANICAL ANALYSIS / PERCENT FINER THAN 1"	1/2"	1/4"	No. 10	No. 20	No. 40	No. 100	No. 200	.02 MM	.002 MM	HYD. ANAL.
8-66GR-	2	MIXED			2.68			100.0	92.8	91.2	88.3	85.8	75.1	34.1	25.0	14.1	5.2	
8-66GR-	3	NATURAL			2.69			100.0	97.7	95.8	91.8	88.4	77.4	35.6	25.8	13.1	4.2	

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

DATE September 3, 1980

SUBJECT PERMEABILITY TESTING - KINGSTON N/S ARTERIAL
PIN 8931.01-321

FROM L. David Suits, Soils Engineering Laboratory Supervisor LDS

TO V. C. McGuffey, Associate Soils Engineer

We have completed permeability tests on the bentonite and sand mixture from the Kingston N/S Arterial using the standard falling head test and the block permeability method, which is also a falling head test. The samples for the test were compacted, using the standard effort, to 129# cu. ft. wet density at 18% moisture.

In the block permeability test a 10 psi effective confining pressure was used and the sample was allowed to consolidate for 24 hours plus.

The results are:

Standard test $K = 7.4 \times 10^{-5}$ cm/sec.

Block test $K = 1.23 \times 10^{-6}$ cm/sec.

LDS/TAC/sas

ITEM 17206.10 SLURRY TRENCH SEEPAGE BARRIER

Description

Under this Item the Contractor shall excavate a trench for an impervious seepage barrier to the dimensions and limits designated in the contract documents. The trench walls shall be retained by replacing excavated earth with a slurry composed of Bentonite in water. The trench shall be back-filled with a mixture of Bentonite slurry and suitable material.

Materials

A. Bentonite

Bentonite used for slurry shall conform to the requirements of the API Standard 13A specification for oil well drilling fluid material, Section 3, Bentonite. The Bentonite shall be certified by a supplier authorized to use the API monogram on drilling fluid materials.

B. Slurry

The slurry used in the backfill mixture shall be composed of Bentonite and water. The slurry shall contain a minimum of four percent by weight of Bentonite uniformly dispersed throughout the slurry fluid. The Bentonite used shall conform to the requirements specified under Section A.

C. Backfill Material

The backfill material shall consist of a homogenous mixture of Bentonite slurry and natural soil. Natural material obtained from below the ground water surface existing at the time of construction and material containing deleterious or organic material shall not be used for backfilling the trench. The natural soil shall be approved based on a visual inspection by the Regional Soils Engineer. The slurry and natural material shall be mixed in the approximate proportions of one part slurry to ten parts of natural material, by weight.

Construction Details

A. General

The Contractor shall be responsible at all times for the carrying out of all excavation operations in a safe and prudent manner so that the workmen and the public will be protected from unreasonable hazard. All applicable local, State and/or Federal requirements shall be observed and necessary permits acquired by the Contractor.

The Contractor shall install safety wire fence meeting the requirements of Subsection 107-05E Safety Wire Fence, to protect the public from trenches left open overnight or on non-working days.

The opened trench shall be held stable with a slurry having the composition indicated in Materials Section B. It is the Contractor's responsibility to modify the properties of the slurry, as necessary, to support the sides of the trench.

B. Mixing of Slurry

The Bentonite shall be mixed with water until the slurry fluid is smooth, free of clots, and uniform in consistency. The slurry shall not be mixed in the trench. Modification of the slurry contained within the trench shall not be made by adding either water or dry Bentonite in the trench. When modifications are made in the slurry, all slurry within the trench shall be recirculated until the slurry is modified. Thinners, dispersants, deflocculants or any materials which reduce the viscosity of the slurry will not be permitted.

C. Excavation

The trench shall be excavated at the location shown on the plans to a width of three feet and to elevation 175, or as determined by the Engineer. The sides shall be parallel and vertical to insure continuity of the barrier.

D. Backfilling

The initial backfill shall be placed by lowering the material to the bottom of the trench by means of a clamshell bucket, tremie, or other approved method. This method of placement shall continue until the backfill emerges above the slurry surface and until a slope has been formed from the bottom of the trench to the surface. The remaining backfill shall then be introduced, by suitable equipment, from the sloping surface and progressed continuously in one direction until the seepage barrier has been completed. Backfill must be introduced so as to slide progressively down the slope of the backfill previously placed. Free dropping of backfill directly into the slurry filled trench, or backfilling operations which may produce segregation of the materials will not be permitted. The backfill operations shall follow the excavation operation as closely as possible to minimize sloughing of the trench, but shall provide the Engineer the opportunity to insure the excavation has been made to the designed elevation. The Contractor shall clean the trench bottom of any sloughing material as directed by the Engineer. At no time shall the top of the excavation be greater than 150 feet measured horizontally from the top of the backfill. Equipment placing the backfill material shall be located so as not to cause the sides of the slurry trench to cave in.

Method of Measurement

The quantity of seepage barrier shall be the number of cubic yards of material computed from the payment lines shown in the Contract Documents. No payment will be made beyond these lines unless the Engineer specifically states in writing prior to the performance of the work, that payment will be made to revised payment lines.

A. Bottom Payment Line

Elevation 175

B. Top Payment Line

Original ground surface at the centerline of the tren ch or, in a fill section, the top of the designed fill at the centerline of the trench.

C. Side Payment Lines

Vertical to the Bottom Payment Line

D. Width

Three (3) Feet

Basis of Payment

The unit price bid for this item shall cover the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work, including the cost of excavation, furnishing Bentonite and water, mixing and placing the slurry, furnishing and preparation of the backfill material, backfilling, cleanup including disposal, and required protection.

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS BUREAU

CASE STUDY

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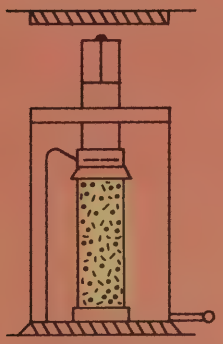

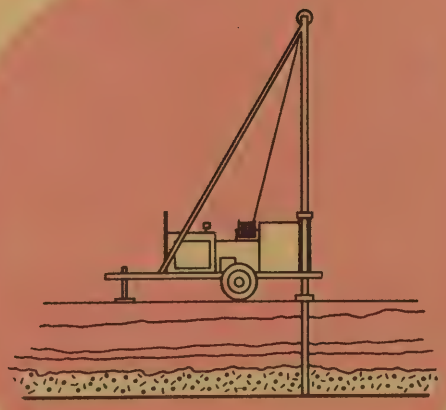

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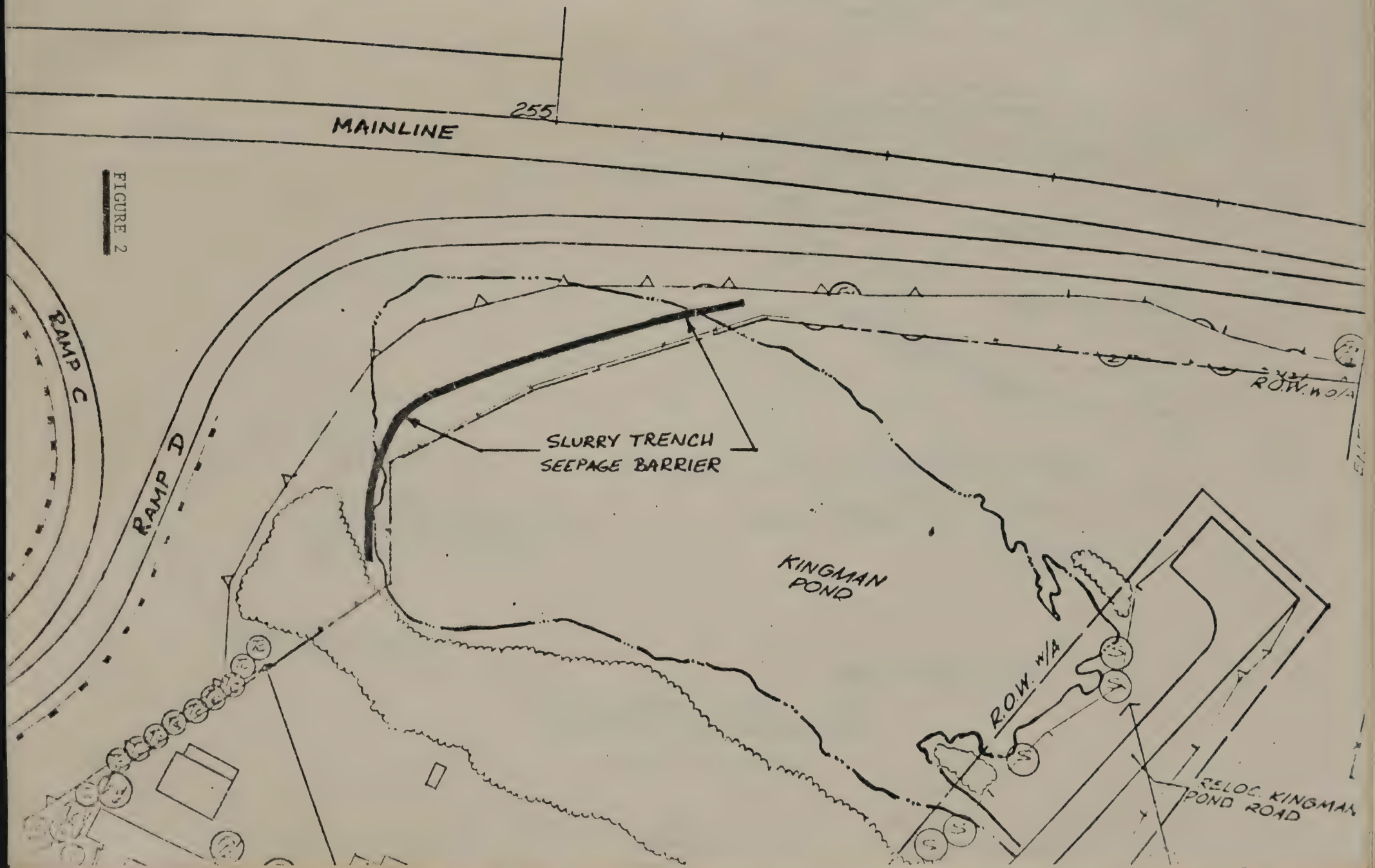
FIGURE 1

REG. NO.	STATE	PROJECT NO.
1	N.Y.	F-11(105)
CITY OF KINGSTON		
NORTH - SOUTH ARTERIAL		

FIGURE 2

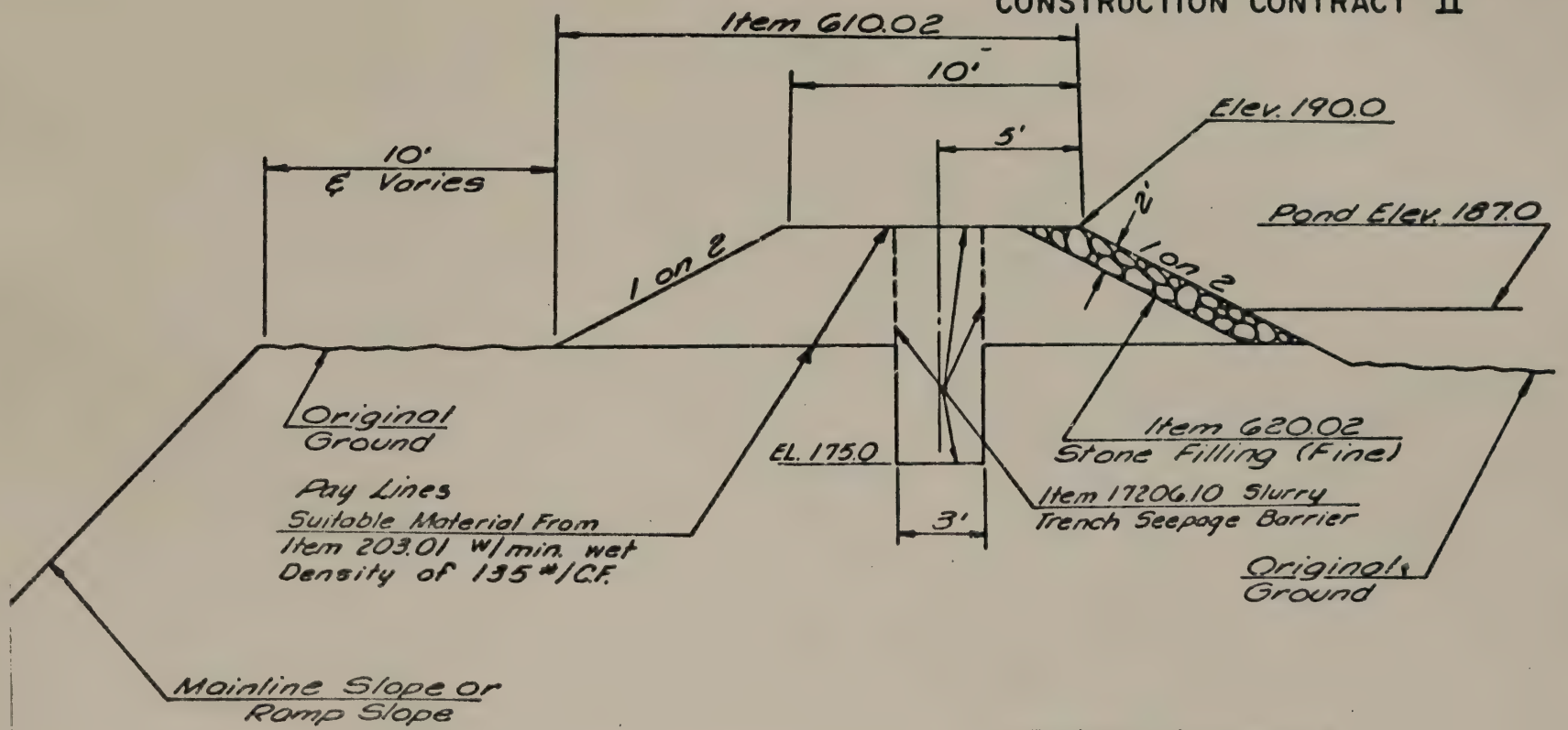


D95913

FED. RD. REG. NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
1	NEW YORK	F-11(108)	33	145

CITY OF KINGSTON
NORTH-SOUTH ARTERIAL HIGHWAY

CONSTRUCTION CONTRACT II



D14+80 ± to D 18+80 ±

KINGMAN POND DIKE

(NOT TO SCALE)

FIGURE 3

APPENDIX

SM 105b (11/72)

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION BUREAU OF SOIL MECHANICS

SHEET NO. 1 OF 1

DATE July 1980

SUMMARY OF LABORATORY TEST RESULTS

PROJECT _____ REGION ___ COUNTY _____ PIN NO. _____

LABORATORY NO.			OPT. MOISTURE - %	MAX. DRY DENSITY LBS. PER CU. FT.	SP. GR. + No. 40	LIMITS / LIQUID LIMIT - %	PLASTIC	SEIVE ANALYSIS / MECHANICAL ANALYSIS / PERCENT FINER THAN 1"	1/2"	1/4"	No. 10	No. 20	No. 40	No. 100	No. 200	.02 MM	.002 MM	HYD. ANAL.
8-66GR-	2	MIXED			2.68			100.0	92.8	91.2	88.3	85.8	75.1	34.1	25.0	14.1	5.2	
8-66GR-	3	NATURAL			2.69			100.0	97.7	95.8	91.8	88.4	77.4	35.6	25.8	13.1	4.2	

DRAFT

D. HILTON
REVIEW & COMMENT

STATE OF NEW YORK

DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS BUREAU

CASE STUDY

SLURRY TRENCH
SEEPAGE BARRIER

ON

KINGSTON NORTH SOUTH ARTERIAL
DELAWARE AVENUE INTERCHANGE
D95913
ULSTER COUNTY

PIN 8139.01-321

BY

RICHARD S. GRANA
SENIOR SOILS ENGINEER

JANUARY 1981

I INTRODUCTION

Proposed construction of a ramp on the subject project posed a definite threat to the continued existence of a pond. The problem was the possibility of pond water seeping out and exiting on a cut slope for the ramp located adjacent to, and at a lower elevation than the pond. The recommended solution to the problem was the construction of a slurry trench seepage barrier around the pond in the affected area.

II PROJECT DESCRIPTION

In April of 1979, a contract was let for a portion of the Kingston North-South Arterial. The construction consisted of a small piece of mainline pavement (.46 mi.) and a complete interchange with Delaware Avenue. Figure 1 indicates the general location of the project while Figure 2 shows the actual problem area.

The design of the project was done by McFarland-Johnson-Gibbons Engineers, Inc. with review, letting and award by the New York State Department of Transportation. Inspection was performed by Clough Associates in conjunction with the State.

III DESIGN

During a review of the project with respect to possible soil or rock problems, it was determined that the proposed construction of "D" ramp posed a potential problem. The new ramp, an on-ramp from Delaware Avenue to the arterial northbound, would be constructed in a maximum 20 foot cut 70± feet away from Kingman Pond. A review of the borings indicated a silty sand overlying clayey silt containing layers of fine sand. Concern was expressed as to the possibility of draining the pond by progression of the cut due to future underground seepage through the silty sand. The recommended treatment of the Soil Mechanics Bureau, in conjunction with the Regional Soils Engineer, was the use of a slurry trench seepage barrier. The slurry trench barrier was designed three feet wide and extended approximately 400 feet around the affected

area of the pond. Excavation was to be progressed to elevation 175 which resulted in a trench depth of approximately 15 feet. (See Figure 3). Excavation to this elevation took the bottom of the trench into the clayey silt layer. Since part of the trench location fell within the existing pond, it was necessary to construct a dike so construction of the trench could be made above water. A special note was included in the proposal which required the Contractor to install the slurry trench barrier prior to any excavation for the "D" ramp.

The specification for the slurry trench was developed to include excavation, mixing of the slurry fluid mixing of the backfill (soil and slurry), and back-filling. Payment was made on a cubic yard basis. (See specification in Appendix). An estimate of 500 cubic yards was included in the proposal.

IV CONSTRUCTION

Yonkers Contracting was the prime contractor for the project. The mixing of the slurry fluid and supervision of the mixing of the backfill soil and slurry was sub-contracted to Moretrench American Corporation of Rockaway, New Jersey, a slurry trench outfit. Excavation of the trench, mixing and placement of the backfill material was performed by Yonkers.

Mixing of the slurry was done in a 6,000 gallon tanker furnished by Moretrench. (Photo 1). Water was obtained by either pumping from Kingman Pond or, when the pump broke down, from a public supply. (Photo 2). Eighteen bags of Bentonite were added to the approximately 6,000 gallons of water resulting in the minimum 4% by weight of Bentonite required by the specification. Thorough mixing in the tanker was accomplished by circulation through a header-pipe system as seen in Photo 1. Total time to prepare an acceptable batch of slurry fluid was approximately 45 minutes. Even though there was no specification requirement to do so, the Consultant chose to test the viscosity of the mix by the use of a Marsh Funnel Viscometer. (See Photo 4). A measure of viscosity is made by filling the funnel with 1500 cc's of slurry fluid and timing the

rate for 1 quart (946 cc's) to flow out. Industry recommends a viscosity of 35-40 seconds minimum for a slurry trench application. Readings in the range of 35 to 40 seconds were obtained for the specified mix.

Excavation of the trench was performed by a Cat. Backhoe with an approximate 1 yard bucket. As the excavation was being progressed, slurry fluid was continually pumped into the trench. (See Photos 5, 6, 7). This procedure was carried out until the 6,000 gallons of slurry ran out; usually in from 20-30 minutes. A 45 minute delay then ensued while a new batch of slurry was mixed. Excavation of the trench progressed in this manner for a distance of 75 feet, at which time mixing of the backfill started.

The backfill mixture consisted of 10 parts soil to 1 part slurry fluid. Mixing was performed in a basin constructed near the trench. At the start, a gradall and the backhoe did the mixing by spreading acceptable natural soil over a pool of slurry fluid and working it with both buckets. (See Photos 8, 9, 10, 11). When the mixture was at the right consistency, backfill operations commenced. The right consistency was determined "by feel" of the foreman of Moretrench.

Prior to starting of the backfill operation, slurry fluid was withdrawn from the trench to a depth of from 3 to 4 feet below the top to allow for displacement by the backfill. This slurry was re-used at a later time. Placement of the backfill was started at one end of the trench by the gradall and continued until it appeared above the level of the slurry. (See Photo 12). Subsequent backfill was placed so as to slide down the sloping face thus advancing the backfill operation. The Consultant checked depths of the trench with the use of a graduated pole. (See Photo 13). Also checked for information, was the slope of the advancing fill. It was found to range between a 1 vertical on 2 horizontal to 1 vertical on 3 horizontal.

The use of a gradall to mix and place was found to be a very slow process.

The Contractor very quickly eliminated the gradall and replaced it with a Cat. 977 Track Loader which performed both operations quicker and satisfactorily. (See Photos 14, 15). The whole operation was executed between July 8 and July 16, 1980. The Contractor chose to cover the completed trench area with 2 feet of broken rock. (See Photo 16). The Contractor was paid for 541 cubic yards of trench at his bid price of $70 per cubic yard.

V GENERAL

To gather some information on the natural backfill soil and on the actual backfill mixture of slurry and soil, a sample of each was obtained and tested. Gradation, specific gravity and permeability tests were performed. The results of all testing can be found in the Appendix.

IV EVALUATION

Actual construction of the slurry trench seepage barrier progressed without any major problems once a few early "bugs" were ironed out by the Contractor. These dealt mostly with the slowness of the operation, as described previously. No problems were encountered because of faulty design. There were, however, several suggested changes to the specification made by the Consultant. These are as follows and are made in reference to the appropriate specification subsection:

A. Bentonite

A more specific specification requirement concerning the type and quality (grade) of Bentonite should be stated based on the intent of the construction.

B. Slurry

1) Reference should be made to a minimum Marsh Funnel Viscometer reading.

2) A water quality requirement should be included.

C. Backfill Material

1) A specific gradation requirement should be included and not have acceptance based on a visual approval of the Regional Soils Engineer.

2) If the slurry and natural backfill material are to be mixed proportionately by weight as specified, a pug-mill or other approved mixing operation should be required. SEE REMARK LAST PAGE

D. General

The Contractor should be required to supply any test equipment as needed.

The Consultant's comments have merit and should be evaluated for future projects. It is important to realize that it is impossible to write one specification for all projects and that each project and application should be looked at individually.

VIII POST-MORTEM

Although the seepage barrier has been completed for only approximately six months, two events occurred which are worth mentioning. During Construction of the ramp, water started seeping from the cut slope. (See Photo 17). It is believed that this water was trapped between the slurry barrier and the newly formed cut slope face. Filter cloth and a two foot blanket of slope protection was utilized as stabilization where required.

The second, and more spectacular, event to occur can be clearly seen in Photo 18. The pond dried up!! This occurred a short time after completion of the seepage barrier. Contrary to popular belief, this "happening" probably was due to the severe drought which has plagued the area for approximately one year and not the installation of the seepage barrier.

the later part of November 1980 [illegible] to retain water

VIII CONCLUSION

Based on experience obtained during construction, it appears that no major problems exist with the design and use of a slurry trench as a seepage barrier. Some minor adjustments should be made to the specification. Each application should be studied separately and the specification modified for the intended use.

REMARKS: THE NEED FOR SPECIFYING the backfill & slurry mixture in terms of proportion by weight is questionable. Query? is the need for proportion the backfill & slurry in these exact proportion necessary. IF ANSWER IS YES a pugmill or other mixing equip will be needed ergo increase cost of installation — BENEFIT?

IF ANSWER IS NO a more general mixing specification is called for ERGO decreased cost of installation — BENEFIT?

Literature on MARKET

1. FORMATION OF FILTER CAKES ON SIDE OF TRENCHES is the most important item in construction of slurry trench
2. METHOD OF BACKFILLING TRENCH - TO MINIMIZE DAMAGE TO FILTER CAKES
3. BACKFILL MATERIAL
4. TYPE - GRADE BENITONITE

CONSISTENCY OF BACKFILL & SLURRY MIXTURE — test by slump cone? CONTACT EXPERTS IN FIELD

STATE OF NEW YORK

DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS BUREAU

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II PROJECT DESCRIPTION

In April of 1979, ~~a~~ D95598 contract was let for a portion of the Kingston North-South Arterial. The construction consisted of a small piece of mainline pavement (.46 mi.) and a complete interchange with Delaware Avenue. Figure 1 indicates the general location of the project while Figure 2 shows the actual problem area.

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During a review of the project with respect to possible soil or rock problems, it was determined that the proposed construction of "D" ramp posed a potential problem. The new ramp, an on-ramp from Delaware Avenue to the arterial northbound, would be constructed in a maximum 20 foot cut ABOUT 70~~+~~ feet away from Kingman Pond. A review of the borings indicated a silty sand overlying clayey silt containing layers of fine sand. Concern was expressed as to the possibility of draining the pond by progression of the cut due to future underground seepage through the silty sand TO THE CUT SLOPE. The recommended treatment by of the Soil Mechanics Bureau, in conjunction with the Regional Soils Engineer, was the use of a slurry trench seepage barrier. The slurry trench barrier was designed three feet wide and extended approximately 400 feet around the affected

area of the pond. Excavation was to be progressed to elevation 175 which resulted in a trench depth of approximately 15 feet. (See Figure 3). Excavation to this elevation took the bottom of the trench into the clayey silt layer. Since part of the trench location fell within the existing pond, it was necessary to construct a dike so construction of the trench could be made above water. A special note was included in the proposal which required the Contractor to install the slurry trench barrier prior to any excavation for the "D" ramp.

The specification for the slurry trench was developed to include excavation, mixing of the slurry fluid, mixing of the backfill (soil and slurry), and THE ACTUAL back-filling PLACEMENT. Payment was made on a cubic yard basis. (See specification in Appendix). An estimate of 500 cubic yards was included in the proposal.

IV CONSTRUCTION

Yonkers Contracting was the prime contractor for the project. The mixing of the slurry fluid and supervision of the mixing of the backfill soil and slurry was PERFORMED UNDER THE DIRECTION OF ~~sub-contracted to~~ Moretrench American Corporation of Rockaway, New Jersey. ~~a slurry trench outfit~~. Excavation of the trench, mixing and placement of the backfill material was performed by Yonkers.

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rate for 1 quart (946 cc's) to flow out. Industry recommends a viscosity of 35-40 seconds minimum for a slurry trench application. Readings in ~~the~~ THIS range ~~of 35 to 40 seconds~~ were obtained for the specified mix.

Excavation of the trench was performed by a Cat. 235 Backhoe with an approximate 1 CUBIC yard bucket. As the excavation was being progressed, slurry fluid was continually pumped into the trench. (See Photos 5, 6, 7). This procedure was carried out until the 6,000 gallons of slurry WAS UTILIZED ~~ran out~~; usually in from 20-30 minutes. A 45 minute delay then ensued while a new batch of slurry was mixed. Excavation of the trench progressed in this manner for a distance of 75 feet, at which time mixing of the backfill started.

The backfill mixture consisted of 10 parts BY WEIGHT OF soil to 1 part slurry fluid. Mixing was performed in a basin constructed near the trench. At the start, a Gradall and the backhoe did the mixing by spreading acceptable natural soil over a pool of slurry fluid and working it with both buckets. (See Photos 8, 9, 10, 11). When the mixture was at the right consistency, backfill operations commenced. The right consistency was determined "by feel" of the foreman of Moretrench.

Prior to ~~starting of the backfill operation~~ INITIAL BACKFILLING, slurry fluid was withdrawn from the trench BY PUMPING, to a depth of from 3 to 4 feet below ~~the top~~ ORIGINAL GROUND to allow for displacement by the backfill. This slurry was re-used at a later time. IT WAS NOTED THAT A CAKING OF BETONITE HAD OCCURRED ALONG THE TRENCH WALLS. Placement of the backfill was started at one end of the trench by the Gradall and continued until it appeared above the level of the slurry. (See Photo 12). Subsequent backfill was placed so as to slide down the sloping face thus advancing the backfill operation. The Consultant checked depths AND WIDTHS of the trench with the use of a graduated pole. (See Photo 13). Also ~~checked~~ DETERMINED for information, was the slope of the advancing fill. It was found to range between a 1 vertical on 2 horizontal to 1 vertical on 3 horizontal.

The use of a gradall to mix and place THE BACKFILL was found to be a very slow process.

The Contractor very quickly eliminated the Gradall and replaced it with a Cat. 977 Track Loader which performed both operations quicker and satisfactorily. (See Photos 14, 15). The whole operation was executed between July 8 and July 16, 1980. The Contractor chose to cover the completed trench area with 2 feet of broken rock, FOR SAFETY REASONS. (See Photo 16). The Contractor was paid for 541 cubic yards of trench at his bid price of $70 per cubic yard.

V GENERAL

To gather some information on the natural backfill soil and on the actual backfill mixture of slurry and soil, a sample of each was obtained and tested DURING CONSTRUCTION. Gradation, specific gravity and permeability tests were performed. The results of all testing can be found in the Appendix.

IV EVALUATION

Actual construction of the slurry trench seepage barrier progressed without any major problems once a few early "bugs" were ironed out by the Contractor. These dealt mostly with the slowness of the operation, as described previously. No problems were encountered because of faulty design. There were, however, several suggested changes to the specification ~~made~~ OFFERED by the Consultant, INSPECTORS - CLOUGH ASSOCIATES. These are as follows and are made in reference to the appropriate specification subsection:

A. Bentonite

A more specific specification requirement concerning the type and quality (grade) of Bentonite should be stated based on the intent of the construction.

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The second, and more spectacular, event to occur can be clearly seen in Photo 19. The pond dried up!! This occurred a short time after completion of the seepage barrier. Contrary to popular belief, this "happening" probably was due to the severe drought which ~~has~~ HAD plagued the area for approximately one year and not the installation of the seepage barrier. TO SET THE RECORD STRAIGHT, THE POND BEGAN RE-FILLING IN NOVEMBER OF 1980 AND EVENTUALLY REACHED ITS NORMAL WATER ELEVATION. NO ADDITIONAL DISTRESS HAS OCCURRED TO THE CUT SLOPE. (PHOTO 20)

VIII CONCLUSION

Based on experience obtained during construction, it appears that no major problems exist with the design and use of a slurry trench as a seepage barrier. Some minor adjustments should be made to the specification. Each application should be studied separately and the specification modified for the intended use. THIS STUDY SHOULD INCLUDE THE NEED FOR SPECIFYING THE BACKFILL AND SLURRY MIXTURE IN TERMS OF PROPORTION BY WEIGHT OR IN A MORE GENERAL MANNER. A COST-BENEFIT DETERMINATION SHOULD BE MADE.

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